SOUTHEASTERN WIND COALITION

Carolinas Development Assistance and Siting Hub

WILDLIFE CONSIDERATIONS FOR WIND ENERGY DEVELOPMENT

Wind energy is a clean, domestic source of electricity, and its development has prompted questions about potential effects on surrounding wildlife. Considerations related to birds, bats, and marine mammals, and their associated habitats, are commonly raised.

In response, wildlife protection measures are incorporated into wind energy development through established planning, review, and permitting processes. For several decades, conservation organizations, scientists, regulatory agencies, and wind energy developers have engaged in research, guidance development, and technical coordination to identify practices and technologies that reduce potential impacts on wildlife and habitats.

A FRAMEWORK FOR MINIMIZING IMPACTS

When it comes to wind-wildlife interactions, both land-based and offshore wind projects follow established guidelines by the U.S. Fish and Wildlife Services[1] and the Bureau of Ocean Energy Management[2], respectively, that inform decision-making from early planning through construction, operation, and decommissioning. Potential impacts from both are evaluated using a mitigation framework that prioritizes avoidance, followed by minimization, and compensatory mitigation where necessary. In addition to these guidelines, developers must comply with applicable state and local laws, which may provide additional layers of protection. For example, in North Carolina, the Department of Environmental Quality oversees the permitting of construction and operation for onshore commercial wind energy operations in accordance with state statute.

At the core of these guidelines are standardized study methods that help stakeholders understand potential impacts and apply lessons learned across multiple projects. Land-based and offshore siting practices ensure wildlife and habitat impacts are mitigated or avoided altogether. After a project is built, ongoing monitoring, technological innovation, and operational techniques continue to minimize potential impacts over time.

1. U.S. Fish and Wildlife Service. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines.
2. Bureau of Ocean Energy Management. National and Regional Guidelines for Renewable Energy Activities.
3. North Carolina General Assembly. Article 21C, Chapter 143 of the General Statutes: Offshore Wind Energy Development.

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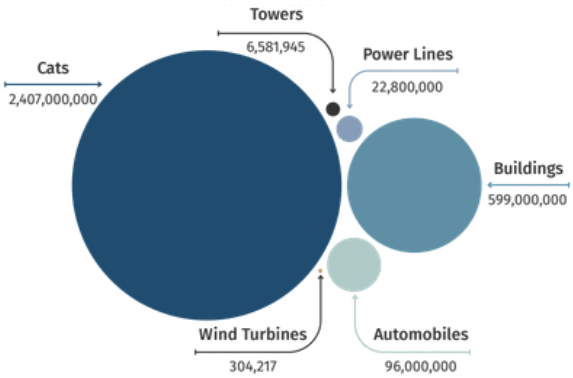
AVOIDING IMPACTS BEFORE CONSTRUCTION BEGINS

Before a wind developer applies for permits and begins construction, they go through a diligent process called “prospecting”. As part of this process, developers evaluate sites and potential risks to wildlife based on existing research and databases. At this stage, red flags will prompt developers to avoid sensitive areas altogether.

For land-based wind projects, this can include **migration corridors, wetlands, or habitats that support endangered species**. For offshore wind, this may include **sensitive seafloor habitats such as reefs, important fishing grounds, whale migration routes, or bird foraging areas**. As the focus narrows to specific sites, experts further characterize them to assess potential impacts on wildlife and determine whether they can be mitigated.

Depending on site characterization and the level of available data, prospective sites may require field studies to inform a project design that minimizes risks to wildlife and, if necessary, identifies compensatory mitigation measures.

ANNUAL BIRD DEATHS FROM DIRECT HUMAN CAUSES, BY SOURCE



Data sources
Automobiles: Rabie et al. 2024
Wind turbines: REWI 2025
All other: Loss et al. 2015

REDUCING LAND-BASED IMPACTS DURING CONSTRUCTION

Following the avoidance step in the mitigation framework, developers implement best practices to reduce impacts on species' use of habitat during construction. Working with wildlife agencies and using scientific guidance, developers set buffers and non-disturbance zones around sensitive areas such as nesting or breeding sites. Even though the construction window for land-based wind farms is relatively short, developers will time construction activities to avoid vulnerable seasons. This helps ensure that habitat remains functional for wildlife, as habitat loss is typically a greater concern than habitat degradation.[4] Direct habitat loss from wind energy infrastructure is relatively small and therefore less of a concern. Strategically, developers prioritize placing turbines, roads, and staging areas on already disturbed or agricultural land. This approach is not only beneficial for wildlife habitat conservation but also for landowners and farmers. Landowners receive lease payments for their land, and 95% of the land within wind farms is still available for agricultural activities.[5]

4. REWI Impacts and Risk Factors to Wildlife and Habitat Guide
5. U.S. Department of Agriculture, Economic Research Service.

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REDUCING OFFSHORE IMPACTS DURING CONSTRUCTION

For offshore wind, mitigation efforts during construction primarily focus on reducing sound impacts on whales and other sensitive species. During monopile installation, developers operate under restricted seasonal windows to avoid interfering with migration or spawning seasons. They also use noise-reduction technologies, such as bubble curtains, which are effective at reducing pile-driving noise.[6]

Additional protective measures include establishing and actively monitoring exclusion zones around vessels to detect marine mammals and sea turtles. Detection of these species requires all surveying equipment to be shut down until the animal leaves the exclusion zone. An added benefit of requiring detections by trained federal observers is that it creates a valuable federal dataset that would otherwise not exist. Vessels operate under speed restrictions to allow the vessels and observers more time to respond if an animal is sighted.[7] According to the National Oceanic and Atmospheric Administration, there is no evidence of harm, and offshore wind farms do not pose a significant risk to marine mammals.[8] Unfortunately, however, collisions from commercial cargo vessels are common in areas with the largest commercial shipping traffic.[9]

Offshore wind developers also use best practices to minimize impacts to seabed habitats during cable installation. This includes avoiding sensitive habitats and conducting benthic habitat and fish-monitoring surveys to assess post-construction recovery. For example, surveys conducted before, during, and after construction at the South Fork Wind Farm in New York found no significant disturbance to benthic communities and a robust colonization of key marine species on the new structures.[10] Colonization of key marine species leads to a domino effect of attracting more, larger species. These findings suggest that offshore wind farms may enhance marine ecosystems.

6. ThayerMahan, Inc.
7. Coastal Virginia Offshore Wind. Construction and Vessel Strike Avoidance Plan (VSAP)
8. National Ocean Industries Association.
9. National Oceanic and Atmospheric Administration, Fisheries.
10. ArcGIS StoryMaps. South Fork Wind: Environmental Monitoring and Results.

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BENEFITS TO FISHERIES AND OFFSHORE HABITATS AFTER CONSTRUCTION

When it comes to fisheries, Northeast fishermen are finding that offshore wind farms offer unexpected benefits.[11] The turbine foundations create additional artificial reef structure, resulting in a "reef effect" where marine invertebrates attach to and grow on the structures, attracting shellfish and, in turn, small and large fish, both of which benefit recreational and commercial fishing. Beyond these inadvertent benefits of offshore wind farms, targeted technological innovations are being developed to intentionally use the wind turbine as an opportunity to increase biomass of economically important species. For example, at wind farms in the North Sea, "cod hotels" are designed to be added onto the turbine foundations to offer shelter and improve the availability of prey for Atlantic Cod.[12]

REDUCING AVIAN IMPACTS AFTER CONSTRUCTION FOR LAND-BASED AND OFFSHORE WIND

For birds and bats, a variety of post-construction mitigation strategies for land-based wind projects are used to minimize the risk of collisions or other potential impacts. The most common way wind facilities reduce bat impacts is through operational "curtailment," temporarily shutting down turbines during peak bat migration periods. Advanced systems use acoustic or visual detectors to curtail operations only when bats are present, while more basic approaches limit operations from dusk to dawn or below certain cut-in speeds, with research showing significant reductions in bat fatalities when turbines operate above 5 m/s. A technology that has proven effective in deterring golden eagles is the use of auditory warning signals when a target species is within a defined area around the turbine. Visual deterrents, such as painting turbines with UV paint, have shown limited promise for raptors and bats. However, painting one turbine blade12 black may show promise for increasing the visibility of moving blades to birds, and additional studies are underway to confirm this approach.[13]

To reduce collision risks for avian species at offshore wind farms post-construction, developers also use visual mitigation strategies, such as lighting modifications. Most commonly used are Aircraft Detection Lighting Systems (ADLS) and shielded navigation lights to reduce constant bright lighting that might attract or disorient birds at night. These aren't deterrents per se, but are intended to minimize the time lights are on and their upward illumination. This mitigates potential attraction or disorientation for nocturnally migrating birds and bats.[14]

Detection technology and ongoing research play a critical role in developing strategies to curtail turbine operations and minimize collisions with birds and bats during higher-risk periods.[15]

11. Conserve Fish. The Ministry of Agriculture, Nature and Food
12. Wageningen University & Research
13. Ecology and Evolution
14. OffshoreWindFacts.org
15. REWI Guide. Minimizing Collision Risk to Wildlife During Operations

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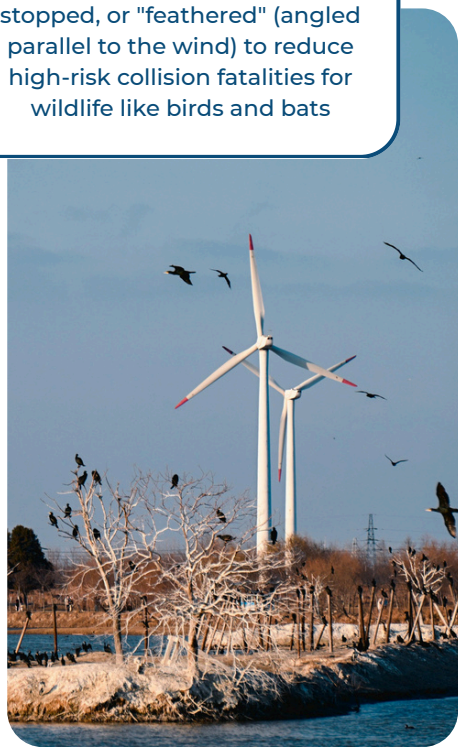
REDUCING AVIAN IMPACTS CONTINUED...

While detection technology and subsequent mitigation strategies, such as curtailment, exist for both land-based and offshore wind farms, a recently deployed technology at offshore turbines and its associated findings are particularly impressive. The technology is the Acoustic and Thermographic Offshore Monitoring™ (ATOM™) systems that were developed and studied by Normandeau Associates.[16] These systems are helping evaluate bird and bat activity around turbines using the Coastal Virginia Offshore Wind Pilot Project turbines.

The main takeaways from these 24/7 monitors are that bird and bat activity mostly occurred when turbine blades were not spinning, no collisions were observed during the first study year, and most detections occurred during fall migration. Interestingly, researchers found that offshore turbines provide potential sites for perching and foraging for birds and bats that did not previously exist offshore, a potential benefit for migrations. Research using technology like ATOM™ helps build mitigation strategies like raising the cut-in speed (or the wind speed at which the turbines will start spinning) and curtailing turbines during high-risk periods, which effectively reduces collision risk for bird and bat populations.

Curtailment Strategy:

A mitigation strategy where wind turbine blades are slowed, stopped, or "feathered" (angled parallel to the wind) to reduce high-risk collision fatalities for wildlife like birds and bats



WILDLIFE & WIND CAN COEXIST

The mitigation framework that guides every stage of wind energy development, from avoidance to minimization and, when necessary, compensatory mitigation, demonstrates that wildlife protection isn't an afterthought. These considerations are central to shaping projects from the earliest stages through construction, operation, and continuous adaptation. As research, monitoring, and technology continue to advance, stakeholders can better respond to potential impacts.

In conclusion, wildlife protection and wind energy development are compatible objectives. When projects are thoughtfully sited and supported by effective mitigation measures, wind energy can provide clean power while maintaining healthy terrestrial and marine ecosystems.

16. Normandeau Associates

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